ON THE OCCURRENCE OF *OKLAHOMACRINUS* IN OHIO AND TIMOR[1]

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ABSTRACT

Previously, the inadunate crinoid genus *Oklahomacrinus* has been reported from the Middle and Upper Pennsylvanian and Lower Permian of the midcontinent region of North America. With the discovery of a new species, described as *Oklahomacrinus ohioensis*, in the Ames Limestone, Conemaugh Group, Upper Pennsylvanian, near Quaker City, Ohio, the geographic range of the genus is now expanded to the Appalachian region. The generic affinity with *Oklahomacrinus* of a species from the Basleo Beds of the island of Timor has long been overlooked; the species, attributed to *Delocrinus* by Wanner in 1916, is here designated as *Oklahomacrinus expansus* (Wanner). With the recognition of the Timor form as a representative of *Oklahomacrinus*, the geographic range of the genus is extended to Asia, and the chronologic range to the Middle Permian (Artinskian).

During the summer of 1964, while collecting fossil invertebrates from the Ames Limestone near Quaker City, Guernsey County, Ohio, I found a specimen of *Oklahomacrinus* representing a new species, which is described below. This discovery expands the geographic range of the genus *Oklahomacrinus* in North America to the Appalachian region.

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Prior to this time, *Oklahomacrinus* had been reported from the Middle and Upper Pennsylvanian and Lower Permian of the North American midcontinent region. However, a species from the island of Timor, attributed to *Delocrinus* by Wanner in 1916, is here designated as *Oklahomacrinus expansus* (Wanner); its affinity with *Oklahomacrinus*, previously unrecognized, is discussed in the present paper. With the genus now known to occur in the Timor fauna, the geographic range of *Oklahomacrinus* is extended to Asia and the chronologic range to the Middle Permian (Artinskian).

I am indebted to Mr. Calvin Colson of Ohio University, for photographs, to Mrs. Diana Pfannebecker of the Ohio Division of Geological Survey for drawings, and to my wife, Emily, for arranging the illustrations for this paper.

SYSTEMATIC PALEONTOLOGY

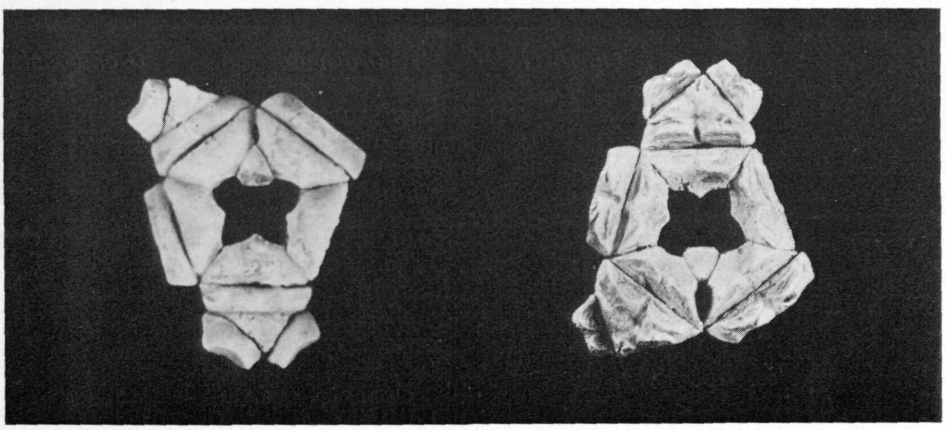
Family Ampelocrinidae Kirk, 1942

Genus *Oklahomacrinus* Moore, 1939

Oklahomacrinus ohioensis sp. n.

Fig. 1, 2

Diagnosis: Resembling *Oklahomacrinus supinus* Moore, but dorsal cup larger (maximum width about 24 mm), radials more convex, basal circlet smaller, and basals much less convex. Posterior basal not truncate on outer surface of cup, but terminating in an apex distally. Radianal eliminated from distal outer surface of the cup by posterior radials, as in *Oklahomacrinus discus* Strimple, and occupying a short, narrow, elliptical area extending from the apex of the posterior basal to the proximal junction of the posterior radials. Surface relatively smooth, but basals granulose.



FIGURES 1, 2. *Oklahomacrinus ohioensis* Burke, sp n. Holotype, O.S.U. no. 26748, from the Ames Limestone, Conemaugh Group, near Quaker City, Guernsey County, Ohio. Fig. 1 (left), dorsal view; fig. 2 (right), ventral view. ×1.

Holotype: O.S.U. no. 26748, part of a dorsal cup (posterior basal and all five radials) and portions of the arms (four primibrachs, two second primibrachs, and three first secundibrachs).

Occurrence: Ames Limestone, Conemaugh Group, Upper Pennsylvanian.

Locality: Roadside exposure on the north side of Ohio Route 256 in the SE¼ SE¼ sec. 26 (lat. 39° 58′ 17″ N, long. 81° 18′ 42″ W), Millwood Township, near Quaker City, Guernsey County, Ohio.

Repository: Orton Museum, Ohio State University, Columbus, Ohio.

Description and discussion: Except for the two second primibrachs, each of which was conjoined with a first primibrach (a common occurence of these plates in *Oklahomacrinus*), all of the plates of the holotype had fallen apart, but were in very close proximity when found. Although the plates fit fairly well in the restoration (figs. 1, 2), some of them, particularly those of the arms, while unquestionably in proper series, may now be placed in rays other than those in which they occurred originally. Because of the unique facets of the posterior basal, the left posterior radial, and the right posterior radial, there can be no doubt that these plates are associated as they were in life.

These three plates are particularly interesting in that they illustrate how the radianal was being eliminated from the outer surface of the dorsal cup in this species. Although, at the outer surface of the cup, the posterior basal comes to an apex distally, within the cup wall it shows a triangular distal facet, the apex of which is directed externally; this facet made contact with the radianal. Each posterior radial also bears a prominent concave facet for the reception of the radianal laterally. The radianal expanded medially, with a prominent exposure bordering the body cavity, and fitted into a wide notch between the radials, reaching nearly to the external margin of these plates distally.

The trend toward the elimination of the radianal from the external surface of the dorsal cup in various North American species of *Oklahomacrinus* is illustrated in figure 3; the plate is essentially unmodified in *O. supinus* Moore, 1939, begins

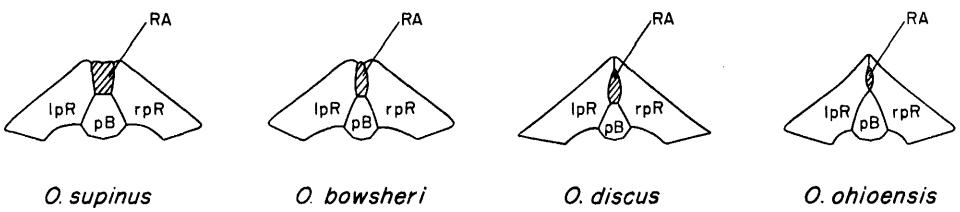


FIGURE 3. Sketches of the posterior interradius in dorsal cups of four North American species of *Oklahomacrinus*, showing the trend toward elimination of the radianal from the outer surface of the cup. pB, posterior basal; lpR, left posterior radial; rpR, right posterior radial; RA, radianal (crosshatched). Diagrammatic and not to scale.

to show an elliptical outline in *O. bowsheri* Moore 1939, is acute distally and shut off by the radials[3] in *O. discus* Strimple, 1947, and similarly shut off by the radials, but acute both proximally and distally, with only slight exposure in *O. ohioensis*. The radianal was also in the course of being eliminated from the outer surface of the crown in the Timor species, *Oklahomacrinus expansus* (Wanner), but in a somewhat different manner. In that form (figs. 4–6) the posterior basal comes to an apex, as in *O. ohioensis*, but the plate is elongate; the radials meet above it, and there is a short exposure of the radianal distally between the radials.

The outer ligament area of each radial is moderately excavated and the external ligament pit is slit-like and deep. The muscle areas of the inner articular region are relatively narrow, though they are wrinkled or rugose adjacent to the intermuscular furrow, and somewhat lamellose toward the lateral boundaries. Between each muscle area and the sharp transverse ridge is an inner ligament area, separated from the muscle area by an oblique ridge that may extend to the "outer lateral corners of the facet", as noted in the radials of *Calceolispongia rotundata* by

[3]Noted by Strimple (1947, p. 6), but his figures do not show details of the posterior interradius. I have not seen the holotype of *O. discus*, which is in the Springer collection of the U. S. National Museum, but Dr. Porter M. Kier (letter, Nov. 9, 1964) assures me that the posterior basal is truncate distally. However, I am entirely responsible if there are any inaccuracies in my sketch of the posterior interradius of the specimen (fig. 3).

Teichert (1949, p. 84, pl. 5, fig. 13). These ridges bend outward toward the transverse ridge as they approach the intermuscular furrow, permitting the furrow to extend to the central pit.

The ventral articular facets of the first primibrachs and first secundibrachs are smooth except for faint denticulations along the outer borders. The dorsal articular facets of the first primibrachs and first secundibrachs, as well as the ventral articular facets of the second primibrachs, are similar to the articular facets of the radials, except that the outer ligament areas are more deeply excavated and the rugae or wrinkles of the muscle areas are usually more pronounced. A furrow separates the two ventral facets of the axillary (second) primibrachs.

In reference to the inner articular ligaments of *Antedon*, Carpenter (1866, p. 714) stated that their "special function seems to be to hold together the plates", and they must have had the same function in *Oklahomacrinus*. However, the principal antagonist of the flexor muscles in *Oklahomacrinus*, as in *Antedon*, must have been the powerful outer ligament. With the relaxation of the flexor muscles after death, the pull of the outer ligament brought the outer marginal ridges of the radial and brachial plates in contact (Van Sant and Lane, 1964, p. 38–39). This is the position of these plates in Moore's illustrations (1939, pl. 9) and in my restoration (figs. 1, 2). While this facilitates illustration of the inner articular surface of the plates, it is somewhat misleading, for, although the arms may have assumed an essentially horizontal position, it may be questioned whether they spread as widely as shown in these illustrations. Furthermore, this pose does not show the extent to which the arms could have been flexed inward. There was muscular articulation between the radials and first primibrachs, second primibrachs and first secundibrachs, and probably, as in *Oklahomacrinus loeblichi*, between the second and third secundibrachs. If, in *Oklahomacrinus ohioensis*, the plates showing muscular articulation are fitted so that they hinge along the knife edges of their transverse ridges with the flexor muscle areas in facing position, it would appear that the tips of the arms could have been held upright or even bent inward.

It is interesting to note that, when the plates are articulated in the position noted above, they show gaping sutures similar to those found between the radials and primibrachs of various species of *Ampelocrinus*.

Measurements of the dorsal cup of the holotype, in millimeters, were taken in accord with Moore (1939, p. 260), and are as follows:

Height of cup	ca. 5.0
Greatest width of cup	ca. 24.0
Ratio of height to width	0.21
Length of posterior basal	6.0
Width of posterior basal	4.7
Length of radial	7.8
Length of outer ligament area (radial)	2.9
Length of transverse ridge (radial)	14.2
Width of radial	16.0

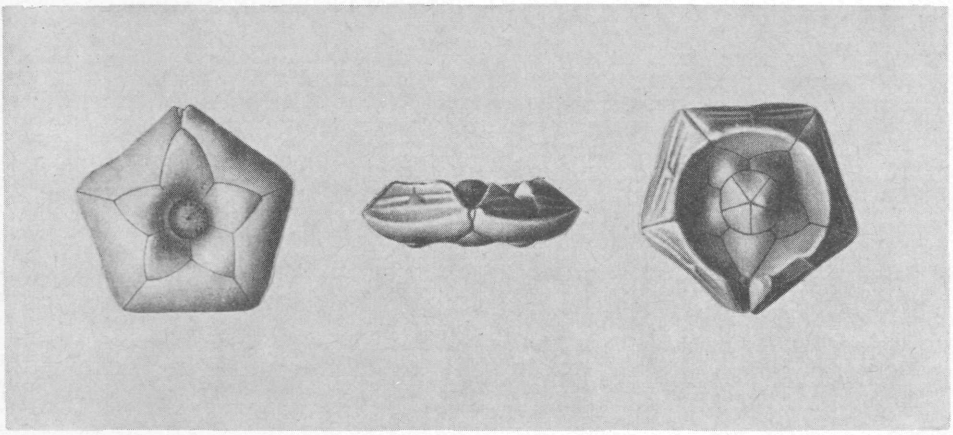
Oklahomacrinus expansus (Wanner)
Figs. 4–6

Delocrinus expansus Wanner, 1916, Die permischen Echinodermen von Timor (Teil 1). Palaontologie von Timor, Lief. 6, Teil II, p. 196–198, pl. 108(13), fig. 5.

Distribution: Basleo Beds, Middle Permian (Artinskian) Island of Timor.

The fact that Wanner attributed this species to *Delocrinus* is understandable, considering the wide range in variation embraced by the concept of that genus at the time he described the species (1916). However, it is surprising that the affinity of the Timor form with *Oklahomacrinus* has gone so long unrecognised; *Oklahomacrinus* has been established as a genus since 1939.

In most respects, *Oklahomacrinus expansus* accords fully with North American species of the genus. It shows the same type of strongly depressed dorsal cup with a marked pentagonal outline in dorsal and ventral views. From within the body cavity, the infrabasal cone rises somewhat above the upper margin of the radial facets, as in some of the North American species. The articular facets of the radials are characteristic of *Oklahomacrinus*, in that they slope outward; the outer ligament area is subvertical, with an outer ligament fossa that is excavated



FIGURES 4–6. *Oklahomacrinus expansus* (Wanner). Holotype, from the Basleo Beds, Timor. Fig. 4 (left), dorsal view; fig. 5 (center), posterior view; fig. 6 (right), ventral view. ×1 (after Wanner).

and prominent. The inner ligament area is short; its muscle areas are delimited from the fossae for the internal ligaments by distinct ridges, and the internal ligament fossae have greater transverse extent than those of *Delocrinus*. The angles formed by the interradial sutures approximate those noted by Moore (1936, p. 255) as distinguishing *Oklahomacrinus*.

The posterior basal comes to an apex distally, as in *Oklahomacrinus ohioensis*, but it is much more elongate than that of the North American species, exceeding the other basals considerably in length. The posterior radials meet above the posterior basal, but diverge distally, permitting a slight exposure of the radianal on the outer surface of the cup. As noted previously in the description of the Ohio species, the elimination of the radianal from the outer surface of the cup was being attained in a different fashion in *Oklahomacrinus expansus* than in *O. discus* and *O. ohioensis*, in which species the posterior radials meet above the radianal, and that plate makes contact with the posterior basal proximally.

The Timor form, with a dorsal cup measuring 28.6 mm in width, represents the largest known species of *Oklahomacrinus*.

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